FORUM

Finding Out What Makes Animals Tick—Genetically

Since Watson and Crick first discerned the structure of DNA 50 years ago, scientists have been studying it, hoping to unravel the mysteries of animal and plant growth and reproduction. Agricultural scientists have constantly sought to put the burgeoning knowledge to practical purposes, breeding animals with natural resistance to disease or ones that produce more efficiently.

In the beginning, decoding the series of genes that make up DNA strands, unique to each living organism, was very slow and tedious. In the early 1980s, tools such as polymerase chain reaction and short tandem repeat DNA markers started us in the right direction.

The late 1980s and early 1990s saw DNA technology evolve rapidly, thanks to large amounts of money being dedicated to human genome study. A genome is all the genetic information or hereditary material possessed by an organism. Scientists hope that by learning about the genes that make a human being—and the roles they play in health and growth—it may be possible one day to cure hereditary problems, such as Tay-Sachs disease, various forms of cancer, and Parkinson's.

Concurrently, scientists in the animal-research community began working with counterparts involved in human genomic studies. The quality and speed of DNA analyses were aided by development of improved, automated sequencing technology. Greater computer capabilities and specialized software made it feasible for researchers to manage the huge amount of data generated by DNA analyzers, doing in days or weeks what previously took months in a laboratory.

Today, with agencies and universities from several countries helping to conduct it, animal genomic research has become a worldwide effort. One of my responsibilities is to represent ARS and USDA as a member and executive secretary of the Interagency Working Group on Domestic Animal Genomics. The group, formed in 2002, coordinates the genomic research of eight U.S. federal agencies through the National Science and Technology Council, a cabinet-level council that creates science and technology policy for the U.S. government.

For fiscal year 2004, Congress appropriated more than $33 million for ARS's animal genomics research. It represents a great investment in the agency that has already quickened the pace of genomics research. Soon, research that took 10 years to complete in the 1980s may be completed in just a few years. And application of this new knowledge may range from producing consistently tender steaks to preventing human diseases.

Scientists are now—or shortly will be—sequencing the genomes of the cow, pig, honey bee, and chicken. This work will help to pinpoint all the genes and, eventually, the various functions they govern. Sequence maps will make it possible to more easily unravel interactions between genes. Quantitative geneticists have theorized for decades that it's these interactions that create the phenotypic effects that are economically important.

Many animals are genetically similar to each other. Sheep and goats are ruminants and are genomically similar to cows. Likewise, turkeys are similar to chickens. So researchers already have the advantage of knowing a lot about these animals without having to spend time and money physically mapping the location of each and every gene.

The Interagency Working Group is beginning to explore the possibility of sequencing the catfish, rainbow trout, and Pacific oyster. Nonagricultural animals, such as the mouse and dog, have already been mapped by other groups. Agency researchers are able to access and use this information as well.

The article beginning on page 4 illustrates the genomic work that ARS—with collaborators from around the world—has already accomplished with these animal species. The objectives of genetics and genomics research extend far beyond the traditional goal of producing adequate quantities of safer, better, and cheaper food. Completed maps will allow scientists to compare the genetic makeup of these agriculturally important animals to learn more about each of them—and to learn more about humans.

They will also learn ways to improve the health and well-being of farm animals. In an age of bioterrorism threats, it is also necessary to understand the genes that will react if livestock are ever endangered by biological agents.

The National Institutes of Health is a major collaborator with ARS, particularly because of the potential human health benefits that may arise from animal genomic research. For example, completion of the chicken genome will provide a valuable model for human embryology and development as well as for study of reproductive diseases. It should also help to expand knowledge of cancer and other diseases. Researchers study the honey bee because it's a good model for aging. Scientists want to study the honey bee's nervous system as well.

ARS continues to be highly interested in research to produce more efficient animals. Tools developed from genomics research will allow better identification of the proper animal for any particular production system and environment. That will lead to more efficient raising of higher quality meat animals at lower prices to the American and worldwide consumer.

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